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RESEARCH PAPER

The Effect of Data Collection Technique on Estimated Landowner Personal Network Attributes

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Abstract Social network analysis, focusing on the role of interpersonal relationships on the flow of information, trust, and service delivery, is increasingly recognized as a valuable approach to understanding landowner behavior. Landowner personal networks are central to Diffusion of Innovations theory and the Theory of Planned Behavior, both of which are commonly invoked in the design of interventions to encourage sustainable private forest management. However, personal network data can be difficult to obtain for a large sample. We tested the effect of three different personal network name generators on estimates of Minnesota landowners' forestry information networks: a list of generic alter categories, an open-ended written survey, and a combination of written survey and follow-up telephone survey. Generic network data provided a relatively accurate baseline. Personal network data from a written survey provided more detailed data but underestimated network diversity and failed to account for potentially influential weak ties. A combination of written and follow-up telephone survey both doubled estimated average network size from 2.8 to 5.5 alters and increased estimated network diversity from 2.3 alter categories per respondent to 3.7. Network data from the written survey revealed a bias in favor of strong ties that was largely overcome through additional prompting during the telephone survey. A combination of written surveys and telephone or in-person interviews may be the best strategy to balance the benefit of a large sample with the cost of more intensive, yet more reliable, data collection methods.

Keywords Social network analysis · Egocentric networks · Family forest · Landowners · United States

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Introduction

Over the past several decades, private forest conservation research has evolved from a focus on timber supply to the influence of identity and values on landowner motivation for a broad suite of management objectives (Bliss and Martin 1988; Egan 1997; Fischer et al. 2010). Social network analysis is emerging as an important area of study within this new emphasis, focusing on the role of interpersonal relationships on the flow of information, trust, and service delivery (Knoot and Rickenbach 2011; Korhonen et al. 2012a; Kueper et al. 2013). Social network analysis can provide insight into community capacity for adaptive management (Bodin et al. 2006) and recent studies suggest that intentional network development to build social capital can lead to positive conservation outcomes (Floress et al. 2011). Social networks are central to Diffusion of Innovations theory (Valente 1994; Rogers 2003) and the Theory of Planned Behavior (Ajzen 1991). Both theories are frequently invoked to explain land management behavior, suggesting an important role for social networks in influencing land management behaviors.

Understanding the ways that personal networks influence land management behavior requires accurate and reliable data describing both the networks in which landowners operate and relationships between those networks and land management behavior. Network data can be collected by a variety of methods including interviews, surveys, public records, and direct observation. We applied three different network data collection methods to a population of Minnesota family forest owners to test the effect of the data collection instrument on the estimated size and composition of woodland information networks. The importance of this analysis is to inform the interpretation and application of data about landowner personal networks to inform more efficient public investments to promote active, sustainable forest management on private lands. The size and composition of landowner networks describe the number and types of a given landowner's current and past information sources, each of which may exert a different influence on land management behavior. Network data can thus provide important insights into landowners' patterns of information acquisition and decision processes that may inform future educational and other interventions designed to encourage sustainable land management action.

We tested the effect of data collection method on reported forestry information personal networks for a population of Minnesota forest owners. In doing so, we investigated the following research question: Do respondents report more, fewer, or different kinds of alters in different data collection scenarios? The remaining sections of the Introduction provide a brief overview of social network research with a focus on social network data collection in the private forestry domain.

Landowner Personal Networks

A landowner's forestry information personal network includes the individuals and organizations from which he or she has received land management information. These sources may be friends or family as well as natural resource professionals, conservation organizations, or others. The attitudes, opinions, and information that

lead to action are influenced in part by personal networks (Wasserman and Faust 1994). The composition of landowners' personal networks is thus of growing interest. Landowner networks tend to include a mix of peers and professionals (Knoot and Rickenbach 2011; Korhonen et al. 2012b), with peers generally valued as sources of trusted local information and professionals as sources of more specific land management advice (Kueper et al. 2013). Although a large portion of government funding to promote sustainable management of private forest land has supported development of management plans by professionals (Esseks and Moulton 2000), some research suggests that peers may be as influential as professionals in decisions about their land management decisions (West et al. 1988; Schubert and Mayer 2012). This may reflect the relative ease of obtaining information from peers over professionals, but trust, language, or patterns of communication may also affect each group's influence on what landowners do (West et al. 1988; Hujala and Tikkanen 2008; Gootee et al. 2010; Knoot and Rickenbach 2011).

Social networks describe a group of "actors," in many cases individuals, and the strength and durability of the relationships among them. Among other things, ties between individuals within a network may depict social interactions, family relationships, relative positions within an organization, or information exchange. Data on who belongs to a network and ties among its members are typically collected from the members themselves using name generator and interpreter questions, which identify relevant actors and elicit data about them (Marsden 1990).

There are two basic approaches to social network analysis: whole networks and personal (egocentric) networks. Whole network data describe relationships among all members of a bounded, defined network, such as the membership of a conservation organization, owners of land within a designated township, or participants in an educational program. A recent example of a whole network study is Rickenbach's (2009) study of the flow of information within and beyond the membership of a Wisconsin forest owner cooperative. Collection and analysis of whole network data requires high response rates from the network members in order to identify relevant ties between and among members of the network. In whole network studies, the unit of analysis is typically the network itself.

Personal networks by contrast, also known as egocentric networks, focus on the individual as the unit of analysis. Personal network data describe the existence and nature of ties between an individual (ego) and others with whom ego shares a specified type of tie (alters). When collecting personal network data, the respondent is asked to name relations of a specified type. For example, common personal network name generators are "With whom do you discuss important matters?"; "With whom do you socialize?"; or in the context of private forest owners, "From whom have you received information about forest practices?" The data enable analysis of the composition of landowner networks with regard to the types of information and assistance accessible from the network, as well as variation in networks among landowners. These data can then be analyzed to identify patterns of association between network attributes and land management behaviors. For instance, Minnesota landowners who had larger ownerships and more extensive land management histories also had larger forestry information networks (Sagor and Becker in press).

Personal networks are increasingly seen as important influences on private forest conservation. In a study of Wisconsin landowners, Knoot and Rickenbach (2011) found that both peers and experts were important sources of woodland information, but experts were more likely to be named as important sources of timber harvesting information and assistance. Larger information networks were associated with higher application of best management practices, supporting the value of interventions designed to build relationships between landowners and service providers as a means to increase the sustainable management of private forest lands. One way to build relationships is to mobilize knowledgeable, trained landowner volunteers to deliver information to their peers (Fletcher and Reed 1996; Kueper et al. in press). This strategy is central to many Extension forestry programs in the United States (Sagor et al. in press). The use of direct volunteer outreach, for example, through the master volunteer program model is widespread and valued by both learners and educators (Finley and Jacobson 2001; Allred et al. 2011; Kueper et al. 2013). The purpose of Extension forestry master volunteer programs is to mobilize knowledgeable, trained volunteers to educate and inform their peers about sustainable forest management. This is in contrast to dispensing technical land management advice, which is a role generally viewed as best suited to natural resource professionals. Peer learning approaches are an alternative to models of experts conveying facts and information through more formal educational programming (Ma et al. 2012; Kueper et al. 2013).

Network Data Collection Techniques and Variation in Landowner Networks

A variety of methodological challenges constrain both whole and personal network studies, including accurate recall, validity, reliability, and other errors (Wasserman and Faust 1994; Brewer 2000). Social network questions are not familiar to most respondents, may seem intrusive, and may require effort to recall and process. Each of these challenges constrains respondents' ability or willingness to respond to research inquiries and provide complete and accurate network data.

These constraints may explain some of the wide variation in where landowners report obtaining information. The percentage of respondents who received forest-related information from at least one source in a recent study of Minnesota landowners, 77 % (Sagor and Becker in press), was 20 % higher than reported to have received "forestry information" by Salmon et al. (2006) and "land management advice" by Ferranto et al. (2012), almost double the 40 % reported by Measells et al. (2005) and triple the 26 % of owners of 20 or more acres of Minnesota forest land reported to have received "advice" in the National Woodland Owner Survey (NWOS; Butler et al. 2012). While Baughman et al. (1998) do not report a corresponding figure, their percentages for individual sources of information suggest a total at least as high as that reported here. While the differences may reflect variation among regional landowner populations, survey instrument design including language (e.g. "advice" versus "information"), and time frame within which sources were to be named may be factors as well. Data collection method also appears to affect results. Using an interview-based approach, Knoot and Rickenbach (2011) found an average network size of 4.1 alters in a recent study of Wisconsin

landowner networks, which was 36 % higher than a separate study estimated from a mail survey of a similar population (Rickenbach 2009).

The type and form of the name generator itself can have important effects on the network data (Marsden 1990). The number and type of prompts (e.g. list of names, lists of types of alters, or photos) as well as limits on the number of alters that can be named can affect reported network size (Freeman et al. 1987). Describing a method to elicit personal network data via interviews, McCallister and Fischer (1978, p 134) concluded that "in the absence of extensive probing they are likely to forget important people." Bernard et al. (1984), summarizing seven different studies of communication, found that informants' accuracy in recall of social network or communications contacts was only about 50 %. In the Rickenbach (2009) study, it was determined that a high level of trust existed among cooperative staff and landowner members existed, but there were few ties among landowners. He concluded that "[s]uch conversations or events may not be recalled when filling out a questionnaire, but likely do influence decision-making and behavior" (p 598).

However, while recalled network data may not always reveal complete details, they do seem to reveal stable patterns of interaction (Wasserman and Faust 1994). Respondents across multiple types of studies were capable of accurately recalling representative samples of real-world networks (Hammer 1984). Respondents' attempts to recall who else attended specific other events in a series of similar events was highly subject to recall error, yet their data corresponded well to long-term patterns of participation in the series of similar events (Freeman et al. 1987). Furthermore, Campbell and Lee (1991) found that while estimates of network size depended heavily on the name generator used, network composition in terms of alter attributes was more stable. In other words, while estimates of network size varied substantially, attributes like the mean age, educational level, and gender distribution of personal networks within similarly sized networks was remarkably stable across studies. This pattern suggests that while estimated network size varies, the relative composition of those networks in terms of alter category (e.g. public foresters, family members, Extension agents) would be relatively stable across data collection techniques. This has important implications both for the design of future landowner network studies and the interpretation of past research. Network composition may be a more important measure to inform landowner education and awareness interventions because it describes to whom landowners turn for information. While network size is important too, it may be less important to know how many sources of each category a given landowner consults. If network composition is relatively stable across data collection methods, choice of method could be driven by factors other than data quality concerns.

While imperfect recall may nonetheless lead to reliable data, an alternative hypothesis suggests that network data may be biased toward certain kinds of alters. Marin (2004) and Brewer (2000) both found evidence that respondents were more likely to recall, and name, alters with whom they had more frequent contact or stronger ties. If this is true, private forest owners might be more likely to name those sources considered most helpful. For instance, the forester who wrote a customized management plan might more quickly come to mind than a peer landowner with whom they discussed land management options briefly over coffee even though the

two exchanges may both have introduced ideas that led to land management action. Name generators that include relatively few prompts may thus lead to disproportionate nomination of strong ties such as close personal relations or particularly helpful sources. This may be problematic because tie strength is not necessarily an indicator of influence. For instance, weak ties can transmit management ideas or practical tips that can enable new actions or lead to seeking out further assistance. But stronger ties may be needed in order to convey information that is more tacit or difficult to codify and convey (Reagans and McEvily 2003). In the private forest land context, management advice is tacit in the sense that it is property specific and dependent on a multitude of ecological, social, and economic factors. While weak ties could easily convey that timber prices are high, stronger ties, which have more knowledge about the recipient's land and values, might be needed to convey advice about whether or not it's in the landowner's best interest to sell timber. Thus a bias in favor of naming strong ties over weak could skew estimates of actual network composition and underestimate the influence of weak ties. To the extent that knowledge about landowner networks and decision processes inform landowner education programs, this could undermine efforts to encourage sustainable private forest management.

Methods

We compared network data generated by three different techniques: two different name generators on a written, mailed survey and a follow-up telephone survey. Each technique was used to collect personal network data from owners of at least 20 acres of forested land across a heavily forested 12-county area of northern Minnesota, USA. Forest landowners were identified from county tax records pertaining only to those classes that commonly include forested land. Completed written surveys were received from 1,002 respondents between April and July 2010. Accounting for ineligible respondents and bad addresses, the survey had an adjusted response rate of 59.7 % (Sagor and Becker in press). The current study reports network data for a randomly selected subset of 61 written survey respondents who completed follow-up telephone surveys. Forty-one others either could not be reached or declined to complete a telephone survey. The usable response rate for telephone surveys was thus 59.8 %. Nonresponse bias tests revealed no statistically significant differences between respondents and nonrespondents in network size, age, ownership tenure, or the number of management activities completed based on responses to the written survey.

Brewer (2000) discussed three techniques by which to reduce recall-based omission of egocentric network data: nonspecific prompting, multiple elicitation questions, and re-interviewing. We employed these techniques during the data collection process. The written survey included two different methods of obtaining woodland network data: Generic and personal. Only one version of the survey was produced, and all respondents were asked to provide data via both methods. For generic network data, respondents were asked to indicate, by checking a box, whether they "had received woodland information" from any of the following alter

categories listed: family members, other landowners, friends and coworkers, public sector foresters, private sector foresters, loggers, realtors, Extension agents, and conservation or environmental organizations. The survey instrument placed no time constraint on when the information was received. These are referred to as "generic" network data because they did not include actual named networks; rather, they described only the generic categories from which woodland information was obtained. Where indicated, alter categories were consolidated as follows for analysis: (1) "peers" included family members, other landowners, and friends or coworkers; (2) "foresters" included public or private sector foresters; (3) "ERC" included Extension sources, realtors, or conservation or environmental groups; and (4) loggers.

The second data collection method employed in the same survey was use of an open-ended free recall name generator to gather personal woodland information network data. The name generator elicited the names of alters "from whom you've received woodland information," again without specifying any limit on when that information was received. The survey instrument included a table indicating the same nine alter categories. Respondents could write in named alters, then use checkmarks to indicate which categories applied to each. To reduce sensitivity associated with naming personal relations, respondents were encouraged to use pseudonyms or partial names rather than reveal the actual identity, which was not of interest to the study. In a few cases, respondents included alters that did not correspond to the nine categories. These were generally mass media. Where specific media sources were identifiable as originating from a member of a given category, the appropriate category was assigned during analysis even if not indicated by the respondent. All named alters, regardless if classified, were counted. For example, "Minnesota Deer Hunters Association magazine" was categorized as a "conservation or environmental organization" and "[Minnesota Department of Natural Resources] website" was categorized as "public forester." While rare, these *ex post* categorizations were appropriate given the established standard for having received woodland information from the source. Importantly, the definition of a "tie" used in this study did not specify any particular format of information exchange.

The third method was use of follow-up telephone surveys with respondents to the written survey. Survey administrators took care to use similar language to that of the written survey to elicit any additional alter names and to avoid providing information that did not appear on the written survey and that might influence the response. Nonetheless, the conversational nature of the telephone survey did force the respondent to consider each of the prompts perhaps more fully than the written survey. After obtaining verbal consent to participate in the survey, telephone surveys began with a reminder of alter names the respondent provided during the written survey. This was followed by asking "is there anybody else that you've received woodland information from that I should add to the list?" New names were recorded along with the corresponding alter categories. This was followed by asking, category by category, if the respondent had received woodland information from any additional alters. As alter names were recorded during the survey, those names automatically populated a grid on a spreadsheet that included all named sources from both the written and telephone surveys. The interviewer then asked

whether each alter had, to the best of the respondent's knowledge, exchanged woodland information with each of the other named alters. This process was repeated for each pair of alters (dyad) to obtain network density data. Telephone surveys lasted between 5 and 25 min, with the difference driven primarily by the number of alters named.

Density is a measure of the number of ties among alters as a proportion of the total number of possible ties. High-density networks have multiple ties among members, while low-density networks have a smaller number of ties, as illustrated in schematic diagrams in Fig. 1. Density is a meaningful measure because it affects the ease with which information can move throughout a network. Density is also related to the degree to which the network draws on independent pools of knowledge as opposed to simply echoing and reinforcing the knowledge already contained within the network.

To check for bias in network data based on tie strength, respondents were asked to identify their up to four most helpful alters, which were interpreted as strong ties. Based on Marin (2004), we hypothesized that strong ties as indicated by most helpful status would more likely be named early than late because they would come to mind quickly, requiring less cognitive processing or prompting for recall. Weak ties, by contrast, would require more prompting in order to be recalled and named. Hence we hypothesized that strong ties (i.e. most helpful alters) would constitute a higher proportion of the alters named early on the written survey and a smaller proportion of the alters named later on the written survey or first during telephone interviews (i.e. only after additional prompting). To test this hypothesis, we divided alters into three groups: those named first or second on the written survey, those named third or later on the written survey, and those named for the first time on the phone. The division between first or second and third or later was chosen both based on the median network size of two alters and because that point divided the alters named on the written survey into two approximately equal groups.

Results

Descriptive Statistics

The 61 telephone survey respondents averaged 63 years of age, ranged from 29 to 96 years, and had owned their Minnesota forest land for an average of 28 years. Respondents were about evenly split between resident and absentee owners, with 52 % living more than 75 miles away from their nearest Minnesota forest land. All owned at least 20 acres, but 65 % owned less than 100 acres. Only one in four had a written management plan.

Generic Network Data from the Written Survey

Of the 61 respondents to the telephone survey, 76 % noted at least one generic source of Minnesota forestry information on the written survey. Among the nine alter categories other landowners, loggers, and family members were the three most

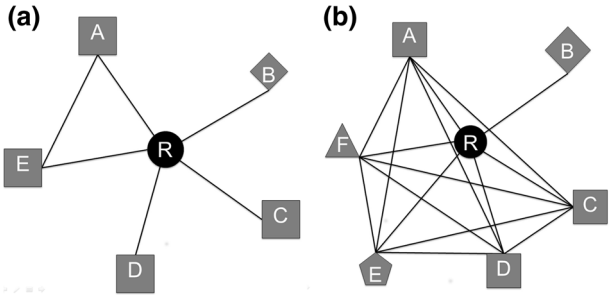

Fig. 1 Schematic diagrams showing hypothetical networks with the same composition but density measures of **a** 0.1 and **b** 0.67. In each case, R is the respondent. *Different shapes* indicate different alter categories

common generic sources of information, followed closely by public sector foresters and friends and coworkers (Fig. 2a). Private sector foresters, conservation and environmental groups, realtors, and Extension agents were all named less frequently. Among grouped categories, peers (family members, other landowners, and friends or coworkers) were the most commonly reported generic category (by 69 % of respondents), followed by foresters (public or private sector; 54 %), loggers (49 %), and ERC (Extension, realtors, and conservation or environmental groups; 36 %). Although generic data give no indication of the number of sources of information within each category, they do indicate network diversity: respondents had received woodland information from a mean of 2.78 (SE = 0.34) different generic alter categories and 1.98 (SE = 0.19) grouped categories.

Personal Network Data from the Written Survey

Of the 61 telephone survey respondents, 77 % reported receiving information from at least one named alter. The total number of alters named on the written survey was 166 (Table 1). Each was assigned by the respondent, to the best of their knowledge, to one or more of the nine alter categories. Individual alters could be members of more than one category, for instance both a logger and another landowner. Because generic and personal network questions appeared on the same written survey (in that order), it is possible that the generic network questions served as a prompt that aided in recall of personal network members, or vice versa. The proportion of respondents naming one or more alters from each category was consistently lower across the nine alter categories than the proportion who reported receiving information from each corresponding generic category (Fig. 2).

Total personal network size from the written survey ranged from 0 to 10 with a median of 2 and a mean of 2.8 (SE = 0.34; Fig. 3), just below Rickenbach's (2009) estimated average network size of three in a recent study of forest landowners in Wisconsin. Estimates of network diversity measured as the mean number of categories represented were smaller for written personal network data than generic data. On average, written personal networks included alters from 2.3 (SE = 0.25) categories and 1.7 (SE = 0.17) grouped categories. Family members were named

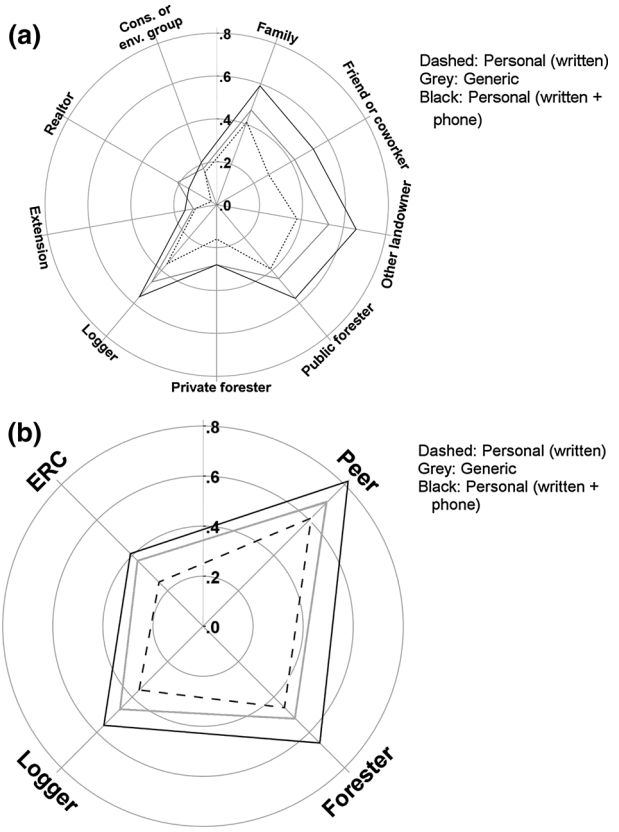

Fig. 2 The proportion of $n = 61$ telephone survey respondents naming alters from each grouped category by data collection method. Differences between written and written + phone are significant at $\alpha = 0.05$ for all categories except private sector foresters, Extension agents, and conservation or environmental groups. Differences between generic and written + phone are not significant. Differences between generic and written are significant only for the realtor category

by the largest percentage of respondents, at 41 %, followed in descending order by public foresters, other landowners, loggers, and friends or coworkers. For grouped categories, significantly more respondents had received woodland information from peers (61 %) than from foresters (46 %), loggers (36 %), or from ERC (25 %; Fig. 2).

Of respondents naming at least one peer as a source, 62 % percent named more than one peer, with an average of 2.1 peers named. By contrast, of those naming at least one forester, only 32 % named more than one (with an average of 1.9 named) and 18 % of those naming at least one logger named more than one (with an average of 1.3). Median network size was two alters. With a mean of 2.3 (SE = 0.25) categories, personal networks based on written survey data were significantly less diverse ($P < 0.01$) than generic networks.

Table 1 Mean number of alters named by category and data collection method for 61 respondents to a self-administered written survey and a follow-up telephone survey

Alter category or grouped category	Written survey	Added during telephone survey	Total[a]
	Mean (SE)	Mean (SE)	Mean (SE)
Family	0.59 (0.100)	0.69 (0.165)	1.28 (0.197)***
Friends and coworkers	0.54 (0.137)	0.38 (0.091)	0.92 (0.147)*
Other landowners	0.67 (0.144)	0.85 (0.148)	1.52 (0.199)***
Public foresters	0.62 (0.133)	0.56 (0.113)	1.18 (0.199)**
Private foresters	0.23 (0.075)	0.23 (0.082)	0.46 (0.118)
Loggers	0.46 (0.092)	0.33 (0.101)	0.79 (0.124)*
Extension	0.13 (0.059)	0.07 (0.032)	0.20 (0.069)
Realtors	0.05 (0.036)	0.15 (0.061)	0.20 (0.069)*
Cons. or env. groups	0.23 (0.068)	0.13 (0.059)	0.36 (0.112)
Peers[b]	1.26 (0.182)	1.39 (0.225)	2.66 (0.264)***
Foresters[b]	0.85 (0.184)	0.77 (0.169)	1.62 (0.280)**
Loggers	0.46 (0.092)	0.33 (0.101)	0.79 (0.124)*
ERC[b,c]	0.33 (0.083)	0.33 (0.090)	0.66 (0.136)*
Total	2.77 (0.336)	2.72 (0.330)	5.48 (0.473)***

[a] Differences between written survey and total: * $P < 0.05$, ** $P < 0.01$, and *** $P < 0.001$

[b] Categories do not sum to grouped category or overall totals because categories are non-exclusive (*i.e.* a single alter might be counted as both a family member and another landowner, but only once in the grouped category "peer")

[c] Extension, realtors, or conservation or environmental groups

Personal Network Data from Telephone Surveys

Average network size increased substantially during the telephone surveys compared with personal network data on the written survey. Despite being reminded of the names provided on the written survey, 49 of 61 telephone respondents named at least one new alter. Average network size doubled, with an average of 2.7 (SE = 0.33) additional named sources of woodland information, bringing total reported network size (i.e. the total number of named alters, regardless of category) up to 5.5 (SE = 0.47; Fig. 3). This difference was statistically significant ($P < 0.001$). Taking total network size as the sum of written and telephone data, the proportion of respondents naming one or more alters from each category was significantly higher across the nine alter categories than the proportion naming a member of each category on the written survey (Fig. 2). This was true at both the alter category and grouped category levels. However, with the exception of the realtor category, differences were not statistically significant at $\alpha = 0.05$ between generic and written or written + telephone data.

Network diversity also increased with the addition of telephone personal network data, rising from an average of 2.3 categories on the written survey to 3.7 (SE = 0.23) after the telephone surveys (Fig. 3). The relatively large increase in network diversity with the addition of telephone personal network data suggests that

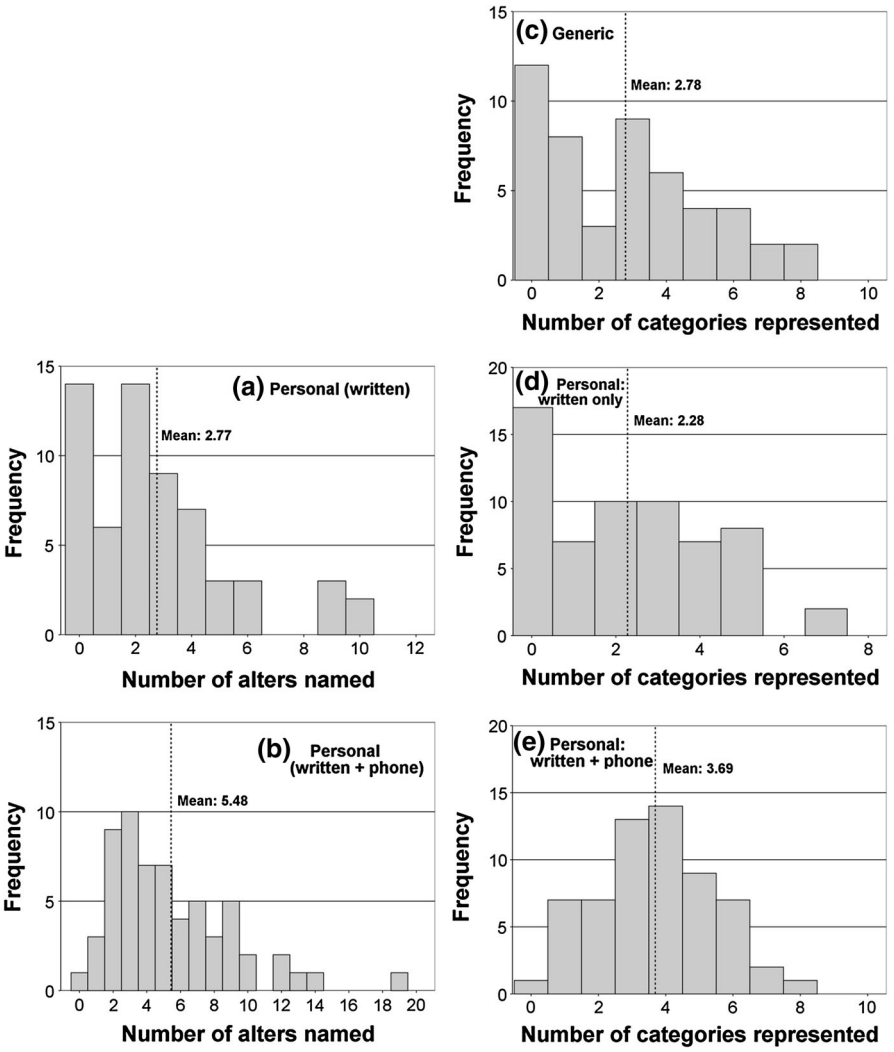

Fig. 3 Variation in estimates of network size and diversity by data collection method ($n = 61$)

many respondents added new categories of alters to their networks rather than simply adding new members of categories already named. Differences in network diversity between written personal network data, generic network data, and written + telephone personal network data were statistically significant ($P < 0.05$ for all differences).

A total of 168 new alters were identified during telephone interviews. No significant differences between the proportion of alters named by category on the telephone versus the written survey were discernible at $\alpha = 0.05$ (Student's T test, Fig. 4). In other words, the alters named for the first time on the telephone were distributed across the nine alter categories similarly to those named on the written

survey. Alters added on the phone were also distributed relatively evenly across small and large networks, and there was no apparent relationship between the size of the network reported on the written survey and the number of new alters added via telephone. The 17 respondents reporting networks of four or more sources on the written survey added an average of 2.67 new alters on the phone, statistically indistinguishable (Student's T test) from the average of 2.74 additional alters reported by respondents with networks of three or fewer sources. In summary, few patterns in alter category or number were evident in the addition of alters after additional prompting on the telephone.

Nor was there a clear pattern in helpfulness by alter category. For eight of nine alter categories, between 30 and 44 % of alters in the category were named one of the four most helpful alters. Only family members stood out as more or less helpful than the other categories, with 55 % of family members named one of the four most helpful alters. Indeed, 62 % of alters named first or second were named most helpful compared with 45 % of those named third or later and 27 % of those named first on the phone. These differences were significant ($P < 0.001$), suggesting a positive relationship between tie strength and recall.

Comparing Data Collection Methods

When comparing generic data from the written survey, personal network data from the written survey, and telephone survey, data collection method influenced the number of alters named as well as the proportion of respondents naming a given category. However, as illustrated in Fig. 2, the proportion of respondents naming at least one member of each grouped alter category increased relatively uniformly, although not always significantly, across categories from personal network (written) to generic network to personal network (written + phone).

Density measures proved unreliable on a pilot test version of the written survey, and were thus omitted from the written survey instrument. Density was included, however, in the telephone surveys. Network density ranged from 0 to 1 with a mean of 0.35 (SE = 0.04). There was no apparent relationship between network size or heterogeneity and density. The lack of evidence for this relationship in our data suggests a need for future research to determine whether landowner networks are different from other kinds of personal networks with respect to density or if the finding simply reflects the small sample size for which density data are available.

Discussion

Personal network data from the written survey revealed less diverse networks than generic network data obtained on the same survey. This may primarily reflect a recall problem: It is possible that some respondents recalled receiving information from a certain type of source but could not recall the source's name. This recall problem seems to have been reduced by the addition of brief telephone surveys, however. The combined written and telephone survey data provide a richer and more complete estimate of landowner personal networks than either of the written

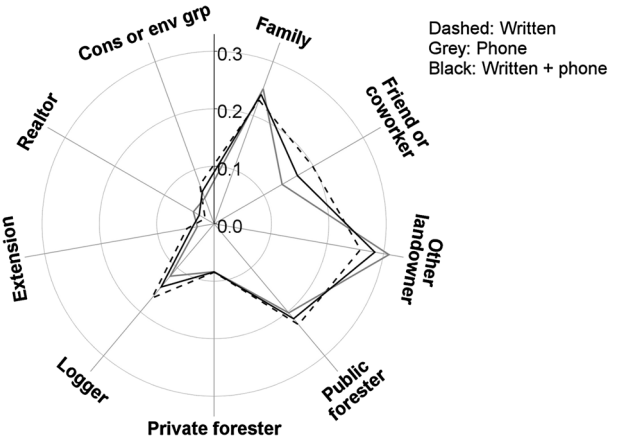

Fig. 4 Proportion of all alters named by alter category and data collection method. No differences between the proportion of alters named in each category by data collection method are significant at $\alpha = 0.05$

survey techniques alone. Considering this finding along with the increase in network size of one-third between Rickenbach (2009, written survey) and Knoot and Rickenbach (2011, telephone interviews) on similar populations of Wisconsin forest owners, telephone contact seems to increase estimated network size.

Both network size and diversity increased with the addition of data from telephone surveys. Estimated total network size nearly doubled. Network diversity estimates varied by data collection method in a pattern similar to network size, with estimates increasing from written personal network data alone to generic network data to written + phone network data. The average number of alter categories represented increased significantly, respectively, from 2.3 to 2.8 to 3.7. Several factors could explain the differences including confusion about what was being asked on the written survey that was clarified during the interviews; relative ease of adding data during a telephone interview compared to a written survey; increased recall due to prompting during the telephone interview; or increased willingness to comply with requests for data during a telephone interview compared with a written survey.

While the percentage of respondents naming members of each alter category increased from written personal network data alone to generic network data to written plus phone network data, the relative composition of networks, expressed as the average proportion of each respondent's network occupied by alters of each category, remained relatively stable across the sample. But there was significant variation in estimates of network diversity across data collection methods. In other words, most landowners did add new kinds of alters on the phone to those named on the survey, but there was little evidence of systematic omission of certain categories of alters by any one data collection method. Some respondents seemed to omit certain alter categories until prompted on the phone, while others seemed to omit other categories.

The relationship between tie strength and recall reinforces differences among the data collection techniques. Minnesota forest landowners were more likely to name

strong ties that they considered most helpful with little prompting, yet only after additional prompting did they name weaker (i.e. less helpful) ties. While helpfulness is a valid indicator of tie strength, this finding highlights a weakness of the written survey method. Diffusion of Innovations theory, as well as social network studies (e.g. Granovetter 1973), suggest that weak ties play an important role in building awareness of options that may be chosen after further consideration and in some cases consultation with strong ties. In fact, observation of land management actions by neighbors and other landowners is a common early step in building awareness of available innovations (Rogers 2003). In some cases the individual whose land is being observed may not be known to the observer, but may nonetheless influence the observer's innovation adoption process. In the current study, with a name generator based on "receiving information from" named alters, these owners would likely not be named at all. Similarly, while the concept of helpfulness was both clear and meaningful as a measure of tie strength, that concept too would largely exclude weak ties who provided critical information to advance a respondent's adoption of a new land management technique. Evaluating landowner social networks based only on data generated from a written survey may systematically underestimate the presence of these important weak ties (as well as some strong ties) in landowner social networks. Collecting personal network data through a more in-depth interview would enable collection of more data not only on tie strength, but on other attributes of the human relationships related to influence through personal networks.

The existence of tie strength bias in written personal network data raises questions about the interpretation of past personal network studies, suggesting that they may underestimate the size of landowner networks. It also highlights an important challenge in future landowner personal network studies. While data collection methods like personal interviews and telephone surveys may reduce tie strength bias in estimates of network composition, the time and cost per respondent of data collection and analysis can be high enough to preclude collection of large sample sizes. While difficult to quantify, it was common during telephone surveys for respondents to seek clarification of the purpose of the study and the meaning of the questions. It seems likely that without these clarifications respondents would not have named additional alters. Future research should investigate the degree to which tie strength bias can be reduced through either additional prompts in a written survey instrument in order to reduce tie strength bias but preserve the efficiency of the written survey. Otherwise, the combination of telephone surveys or in-person interviews and written surveys may be needed to overcome tie strength bias and obtain more complete network data from a large enough and representative sample.

One important advantage of the telephone survey approach is that it allows for the measurement of network density. Concerns about misunderstanding of the meaning of ties among alters encountered in the pilot written survey did not arise in the telephone surveys. The telephone conversational format allowed for quick explanations of any confusion on the part of the respondent, which was not possible on the self-administered written survey. Among other things, network density is related to the degree to which the respondent is able to draw on independent sources of information. If all alters are regularly exchanging woodland information, the chance that those sources share common opinions is higher. If they do not exchange

information with one another, the chance is greater that they would pass along information from independent sources, drawing on a wider variety of perspectives. For example, a landowner who only receives information from tightly interconnected sources might be more influenced by the group's conventional wisdom and less likely to be exposed to different approaches.

These results suggest that consistent with the findings of Campbell and Lee (1991), data collection technique does affect estimated average network size, but not alter category composition. While the percentage of respondents actually naming an individual source of woodland information on either the written survey or the telephone interview was smaller than the number that received information from each generic category, combined network data from the written survey and telephone interviews suggest that in fact the generic network data under-report sources of woodland information. This pattern, which holds across every category and grouped category of alters, suggests that more robust name generators, including a combination of written and telephone surveys, leads to more complete reporting of landowner network data. The relevant difference in our results between data from the written survey and data from the combination of survey and telephone interview is that a higher percentage of landowners are receiving information about their land from more sources than might appear from the written survey alone. Landowners are also receiving information from more diverse sources than it might appear from the survey data alone. Landowner engagement strategies based only on written survey data thus may fail to target landowners through information-seeking behaviors that might in fact reach large proportions of the landowner population.

The choice of which data collection method is best suited to a particular study depends of course on the study's objectives. The combination of survey data from a large sample of landowners, supplemented with telephone survey data on a subset of respondents, produces reliable data on landowner information networks more efficiently than an exclusive focus on interviews would. However, even the combination of written and telephone survey left many important questions unanswered about how networks influence conservation behavior. The kinds of factors that affect the relative influence of one source over another may not be sufficiently easily codified to be reported on a survey. This leads us to the following recommendations for future landowner personal network studies:

1. If a large sample is of value, use a written survey with as many prompts as reasonably possible. Additional prompting on the written survey may increase recall, reducing the effect of recall bias on the results.
2. Use personal interviews, or at a minimum oral surveys, to obtain supplemental data. In the current study, the telephone surveys led to nomination of not only a larger number of weak ties, but also of alters from different categories, increasing the diversity of landowner networks. Longer interviews would offer greater opportunities to develop a deeper understanding of the ways in which networks influence landowner decisions.
3. Investigate how landowners define strong ties and how tie strength relates to influence. Ideally, tie strength data should be collected for each alter named, but where that is not possible it can be collected generically by alter category.

4. Investigate changes in landowner network size and composition at different stages of the innovation decision process. Landowners are likely to seek and use different kinds of information at different decision stages. The most efficient interventions should invest in providing education and information that is most likely to spur action and lead to adoption of sustainable forest management practices. A deeper understanding of the ways that networks change over time and the connections between learning and action, mediated by personal networks, would enable more sophisticated and targeted investments of resources to educate landowners.

Conclusions

Our results suggest that written surveys, the least expensive way to obtain network data from a large sample of landowners, provide relatively accurate picture of landowner personal networks. However, supplementing written surveys with telephone surveys of a subset of respondents allows calibration of the written survey data that may improve the accuracy of network data collected from the larger sample. Additional research would help to develop a deeper understanding of tradeoffs between efficiency and accuracy of personal network data collected from family forest owners. To the extent that these data can inform effective and efficient educational and policy interventions on the ground, this additional research can advance innovation and efficiency of public investments to promote conservation on private forest lands.

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